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# BMJ Open

## Temporary employment and mortality in a large administrative cohort

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## Temporary employment and mortality in a large administrative cohort

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**ABSTRACT**

**Objective**

Precarious employment is characterized by instability, lack of protection, and economic vulnerability. The objective of this study was to assess the association between temporary contracts (TC) and mortality.

**Design**

Cohort study

**Setting**

Rome, Italy

**Participants**

All employees, aged 25-65 years, from the Rome Longitudinal Study followed from 21 Oct 2001 to the first date among death, migration from Rome, or 31 Dec 2015.

**Primary and secondary outcome measures**

We investigated all-cause, cardiovascular, and accidental mortality. We considered gender, age, place of birth, education, temporary vs. permanent contract, and sector of employment. We used Cox models to investigate the association between type of contract and total, cardiovascular and accidental mortality in men and women, overall and by sector of employment.

**Results**

We analyzed 597,834 subjects. The proportion of TC varied by gender (9.6% in men and 13.3% in women) and by sector of employment, ranging from 4.5% (public administration) to 27% (recreational, cultural, sports activities) in men. During the study period 21,136 subjects died. Men with TC, compared to those with permanent contracts, had greater overall mortality risk (HR=1.16, 95%CI: 1.09-1.24), cardiovascular mortality (HR=1.29, 95%CI: 1.14-1.45), and accidental mortality (HR=1.27, 95%CI: 1.04-1.57). In men, the association varied widely among different economic sectors, with greater risks in the industry, building constructions, and social services sectors. In women, the association between TC and mortality was found in the sector of sales and transports only.

**Conclusions**

TC should be taken into account as a determinant of health in particular for specific economic sectors.

**Keywords:** temporary employment, longitudinal study, mortality, vulnerability.

### Strengths and limitations of this study

- The study was based on 597,834 employees aged between 25 and 65 years residents in a metropolitan area, followed for 14 years.
- Census information, linked to health data, allowed a detailed analysis of health outcomes related to temporary work.
- The information on sector of employment allowed to investigate health outcomes related to temporary work in specific sectors.
- The lack of information about job histories was a strong limit of our study.
- There was a lack of information on employees' health and behavioral risk factors.

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**INTRODUCTION**

During the last decades, increased flexibility in the labor market led to the spread of various forms of non-standard and precarious employment in Europe.[1] Due to the growth of evidence on the potential implications on health status, precariousness has been suggested as an emerging social determinant of health.[2] Some studies showed a social gradient in precarious contracts, in terms of educational level and job type.[3,4] In addition, a higher proportion of precarious contracts was reported among women,[5] young adults,[1] and migrants.[6]

Despite the growing body of research, some concerns remain about the definition of precarious employment. According to the seminal work of Rodgers and Rodgers,[7] precariousness is a complex construct that encompasses different dimensions involving employment instability and insecurity, lack of protection, and economic vulnerability. Although some multidimensional methods have been developed to assess precariousness,[8,9] in public health research it is frequent to focus on a specific domain using a one-dimensional approach. Within these domains, temporary employment, an objective measure of precariousness, is one of the most investigated.[10]

Few studies analyzed the effect of type of contract on mortality, showing an association between temporary contracts and mortality in specific subgroups of workers.[11-14] However, all mortality studies were conducted in Nordic European countries and none investigated the impact of temporary contracts among different economic sectors. As rate of temporary contracts may vary widely among economic sectors, the latter were evaluated as confounding factors.[13] Due to the worse working conditions of temporary employees, it is reasonable to hypothesize a joint effect between sector-related and contract-related health risks. Therefore, analyzing the association between temporary contracts and mortality by sector of employment could be more appropriated than adjusting for this variable.

In Italy, reforms in the labor market legislation followed the European trend. Changes in the legislation were carried out during the last decades, starting with the “Treu law” in 1997. This reform introduced temporary contracts and modified regulation of fixed-term contracts, producing more flexibility, and consequently more instability in the labor market. Thus, the aim of

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3 this study was to assess the association between temporary contracts and all-cause and cause-  
4 specific mortality among a cohort of employees between 2001 and 2015 in Rome. Our hypothesis  
5 was that the association between temporary contracts and mortality could be stronger in sectors  
6 characterized by manual work.  
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## 10 11 12 13 14 **METHODS**

### 15 16 17 **Study Design**

18 We used the Rome Longitudinal Study, the administrative cohort of residents in Rome who  
19 filled in the 2001 population census. The study, which has been already described, included all  
20 subjects who were not living in institutions on the census reference day, 21 Oct 2001.[15-17] We  
21 followed the subjects using record-linkage procedures with administrative databases, under strict  
22 control to protect individual privacy. We used the Municipal Registry for vital status and migration,  
23 and Mortality Registry for the cause of death (coded according to the International Classification  
24 of Disease, 9<sup>th</sup> Revision, ICD-9). The follow-up started on the census reference day, and ended on  
25 the day of death, of migration from Rome, or 31 Dec 2015, whichever came first. The Rome  
26 Longitudinal Study was part of the National Statistical Program 2019 and was approved by the  
27 Italian Data Protection Authority.  
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### 40 **Setting and participants**

41 Rome is the capital of Italy, and it is the largest Italian city with about 2.5 million inhabitants  
42 on a surface of 1,290 Km<sup>2</sup> at 2001 census.  
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45 In this study, we selected all employees aged 25-65 years at baseline (78% of the employed  
46 population).  
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### 50 **Patient and public involvement**

51 Patient involvement in the study was not possible, as individual contact information were not  
52 available because of privacy restrictions. Due to the relevance of the topic, the purpose is to  
53 disseminate study results to both population and policy-makers, in order to implement health  
54 promotion and prevention strategies in temporary workers of specific economic sectors.  
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**Outcomes**

We analyzed all-cause mortality, cardiovascular mortality (ICD-9 codes 390–459), and accidental mortality (ICD-9 codes 800–999).

**Temporary employment, sector of employment, and other variables**

The census included several information regarding the occupation for the population aged 15 years or more: occupational status, a binary variable identifying employees and self-employed, the sector of employment, and for employees only, the distinction between temporary and permanent contracts.

The sector of employment was categorized in 28 categories grouped in seven groups, named macro-sectors. The first group was “Fishing and Agriculture” and included agriculture, hunting or forestry, and fishing or fish farming. The second macro-sector was “Industry”. It included coal mining and oil extraction; food industry; textile and leather industry; wood, wood products industry printing and publishing; refinery, pharmaceutical, chemical, rubber, and plastic industry; non-metal mineral (glass and cement) industry; processing of minerals, steel industry, engineering industry, electronics, and transportation equipment manufacturing; manufacture of furniture; production and distribution of electricity, water, and gas. The third was “Building Constructions” comprising public works and installation services in buildings. The fourth was “Sales and Transports”. It included sale, maintenance, and repair of motor vehicles, sale of fuel; wholesale trade and intermediaries of trade; retail trade; hotels, camping, bars, and restaurants; transportation (public and private), warehousing, post, and telecommunications. The fifth was “Credit, insurances and services”, comprising credit, insurance, monetary and financial intermediation; IT, research and development; professional and consulting activities, real estate, and rental. The sixth was “Social Services”, local and national public administration; public and private education and training; public and private health and social assistance; political and trade union organizations; recreational, cultural, and sports activities; other service activities; domestic services for families and institutions. The seventh and final group was “International organizations”.

Among other census variables we selected gender, date of birth, level of education (coded as low for junior high school or less, medium for high school, and high for university or more), and place of birth (Rome, Italy, and abroad).

## Statistical analyses

We computed sex-specific crude mortality rates by age class, type of contract, level of education, and place of birth. We used Cox proportional hazard models to investigate the association between type of contact (temporary vs. permanent employee) and total and cause-specific mortality in men and women, overall and by sector of employment. We used time of follow-up as time axis and we stratified the baseline hazard function by age. We tested for interaction between temporary contract and sector of employment using the log-likelihood ratio test.

As additional analyses, we performed the Cox regression stratifying the baseline hazard function by age, level of education, and place of birth.

As a sensitivity analysis, we performed Cox proportional hazard models to investigate the association between type of contact and mortality until 31 December 2006, allowing only five years of follow-up, under the hypothesis that the information on temporary employment at 2001 census could be more reliable in the first years after the census.

## RESULTS

The cohort included in the study was composed by 597,834 employees aged between 25 and 65 years (53.6% men and 46.4% women), followed for a mean of 12.9 years resulting in a total of 7,712,058 person-years.

Table 1 shows the main socio-demographic characteristics, overall, and cause-specific mortality of the study population. Women had a higher proportion of temporary contracts than men (13.3% vs 9.6%) and were more educated than men (26.5% vs 21.9% high educational level). More than one-third of the employees were born outside Rome, and 4.8% of men and 6.1% of women were born abroad. In the period of interest, there were 21,136 deaths (35.1 and 18.8 per 10,000 person-years in men and women respectively). In men and women, cardiovascular deaths accounted for 26.5% and 14.6% of all deaths, respectively, whereas accidental deaths for 6.2% in men and 3.8% in women. Accidental mortality was almost twice for temporary compared to permanent workers in both men (10.9% vs 5.8%) and women (6.7% vs 3.6%).

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Main characteristics by occupational sectors for men and women are shown in Supplementary Material. In men (Table S1), the macro-sector with the highest percentage of temporary employees was fishing and agriculture (14.7%). The sector with the highest proportion of temporary workers was recreational, cultural, and sports activities, within the macro-category of social services, with 27.1%. Table S1 highlights the differences among sectors in terms of socioeconomic position and origins. The education sector had the highest proportion of highly educated employees (62.9%), followed by the health and social assistance sector (45.7%), whereas the sectors with the lowest proportion were hotels, bars, and restaurants (4.8%) and domestic services (4.9%). The proportion of foreigners varied among sectors with the highest percentage in domestic services (32.1%) followed by international organizations (20.6%).

**Table 1. Characteristics of the study population**

	Men						Women					
	N	%	Number of deaths	% CV Deaths	% AC Deaths	CMR (10,000 p-yrs)	N	%	Number of deaths	% CV Deaths	% AC Deaths	CMR (10,000 p-yrs)
<b>All subjects</b>	320,654	100.0	14,290	26.5	6.2	35.1	277,180	100.0	6,846	14.6	3.8	18.9
<b>Type of contract</b>												
Permanent	289,828	90.4	13,258	26.4	5.8	35.9	240,213	86.7	6,267	14.6	3.6	19.9
Temporary	30,826	9.6	1,032	28.4	10.9	27.0	36,967	13.3	579	14.2	6.7	12.2
<b>Age class</b>												
25-34	83,837	26.1	725	20.6	34.3	7.0	80,257	29.0	421	11.4	15.4	4.1
35-44	102,024	31.8	2,035	25.7	12.1	15.4	93,520	33.7	1,344	11.5	5.1	10.8
45-54	89,910	28.0	5,195	27.3	4.3	44.6	75,688	27.3	2,816	13.2	3.1	28.0
55-65	44,883	14.0	6,335	26.9	2.6	113.2	27,715	10.0	2,265	18.7	1.9	62.9
<b>Education</b>												
High	70,356	21.9	2,585	26.7	5.5	28.5	73,511	26.5	1,551	12.5	3.6	16.0
Medium	144,897	45.2	5,017	26.5	7.1	27.2	140,773	50.8	2,918	12.7	4.4	15.8
Low	105,401	32.9	6,688	26.5	5.8	50.5	62,896	22.7	2,377	18.1	3.3	29.2
<b>Place of birth</b>												
Rome	200,499	62.5	7,671	26.1	7.1	29.9	176,768	63.8	3,909	13.6	4.2	16.8
Italy	104,735	32.7	6,180	27.0	4.8	46.8	83,400	30.1	2,603	15.7	3.1	23.9
Abroad	15,420	4.8	439	28.0	9.1	23.6	17,012	6.1	334	17.7	5.4	15.8

CV cardiovascular

AC accidental

CMR crude mortality rate per 10,000 p-years (person-years)

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Women showed higher percentages of temporary contracts than men in all macro-sectors (Table S2). In women, the macro-sectors with the highest percentage of temporary employees were fishing and agriculture (20.4%), international organizations (17.6%), and sales and transport (14.6%). The lowest proportion was in social services (12.5%). However, in this macro-sector, there was great variability, with the percentage of temporary workers ranging between 31.2% of recreational, cultural and sporting activities, and 5.9% of local, national, and public administration.

Table 2 shows the association between temporary employment and mortality overall and by macro-sector of employment in men and women. Age-adjusted Cox regression models showed greater overall mortality risk for temporary workers in men (HR 1.16, 95%CI 1.09-1.24) but not in women (HR 1.03, 95%CI 0.95-1.12). Results of the likelihood ratio test, comparing the models with and without the interaction term between type of contract and sector of employment, were statistically significant in both men ( $p = 0.04$ ) and women ( $p = 0.04$ ). Among macro-sectors, industry (HR 1.26, 95%CI 1.07-1.49), building constructions (HR 1.29, 95%CI 1.08-1.54), and social services (HR 1.11, 95%CI 1.00-1.25) showed greater overall mortality risks in men, whereas women had higher mortality in sales and transports sector (HR 1.23, 95%CI 1.01-1.49). Overall, men had higher cardiovascular mortality in temporary compared to permanent workers (HR 1.29, 95%CI 1.14-1.45), specifically the association was significant in the macro-sectors of sales and transports (HR 1.33, 95%CI 1.05-1.68) and social services (HR 1.26, 95%CI 1.03-1.55). In women, although in several macro-sectors the hazard ratios were greater than one, there was no evidence of association between type of contract and cardiovascular mortality. Temporary workers had higher risk of accidental mortality compared to workers in permanent positions in men (HR 1.27, 95%CI 1.04-1.57), but not in women (HR 1.34, 95%CI 0.94-1.91).

Table 3 shows the association between temporary employment and overall, cardiovascular, and accidental mortality in men by specific sector of employment. There was an association with

**Table 2. Association between temporary employment and mortality overall and by sector of employment. Men and women, Rome 2001-2015**

	N	N deaths	Overall mortality			N deaths	CV mortality			N deaths	AC mortality		
			HR	95% CI			HR	95% CI			HR	95% CI	
<b>Men</b>													
Overall	320,654	14,290	1.16	1.09 1.24		3,793	1.29	1.14 1.45		884	1.27	1.04 1.57	
Macro-sector of employment													
Fishing and agriculture	3,927	271	0.83	0.56 1.22		67	1.41	0.73 2.71		19	0.92	0.26 3.29	
Industry	44,568	1897	1.26	1.07 1.49		502	1.17	0.84 1.62		130	1.58	0.96 2.61	
Building Constructions	21,058	1047	1.29	1.08 1.54		290	1.31	0.94 1.83		86	1.19	0.67 2.10	
Sales and Transports	79,626	3265	1.12	0.98 1.27		859	1.33	1.05 1.68		225	1.10	0.74 1.64	
Credit, insurances and other services	51,771	1806	1.11	0.89 1.37		476	1.20	0.80 1.81		88	0.95	0.42 2.17	
Social services	117,812	5910	1.11	1.00 1.25		1573	1.26	1.03 1.55		329	1.36	0.94 1.97	
International organizations	1,892	94	0.78	0.33 1.83		26	1.09	0.24 4.85		7	3.87	0.71 20.98	
<b>Women</b>													
Overall	277,180	6846	1.03	0.95 1.12		997	1.02	0.81 1.28		262	1.34	0.94 1.91	
Macro-sector of employment													
Fishing and agriculture	3,032	114	0.71	0.41 1.23		27	0.53	0.16 1.77		1	-	-	-
Industry	19,721	423	1.01	0.73 1.39		70	1.61	0.82 3.19		24	2.21	0.81 6.06	
Building Constructions	3,612	74	0.89	0.38 2.10		12	3.56	0.86 14.7		3	-	-	-
Sales and Transports	51,334	980	1.23	1.01 1.49		132	1.31	0.79 2.16		46	1.57	0.72 3.45	
Credit, insurances and other services	42,745	727	0.90	0.68 1.19		89	0.77	0.33 1.80		33	0.95	0.32 2.83	
Social services	154,755	4493	1.01	0.91 1.13		665	0.85	0.62 1.17		155	1.22	0.75 1.98	
International organizations	1,981	35	1.05	0.35 3.14		2	6.11	0.22 172.2		0	-	-	-
HR adjusted for age													
CV cardiovascular													
AC accidental													

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overall mortality, with higher risks in subjects with temporary compared to permanent contracts, in the steel industry sector (HR 1.34, 95%CI 1.04-1.71) and in the public administration (HR 1.20, 95%CI 1.01-1.43). Higher cardiovascular mortality risks were found in the sector of production and distribution of electricity, water, and gas (HR 3.85, 1.50-9.83), in the retail and trade sector (HR 1.72, 95%CI 1.07-2.77), in the sector which includes professional consulting, real estate, and rental (HR 1.98, 95%CI 1.13-3.49), and public administration (HR 1.56, 95%CI 1.15-2.11). There was a higher risk for accidental mortality in two sectors: steel industry (HR 2.01, 1.04-3.87), and wholesale trade and intermediaries of trade (HR 4.48, 1.52-13.25) with wide confidence intervals due to the small number of deaths. Since there was no evidence of association between type of contract and overall mortality in women, we did not investigate the possible association in specific sectors.

Supplementary Table S3 shows the results from Cox regression models adjusted for age and level of education, and then for age, level of education, and place of birth. The results on the association between temporary employment and mortality in men and women were similar to those presented in Table 2.

The sensitivity analysis conducted on a follow-up from 2001 to 2006, confirmed the results on overall and cardiovascular mortality in men. Results on accidental mortality were based on 345 cases and were not statistically significant. Supplementary Table S4 shows the results of the association between temporary employment and overall mortality by macro-sectors ending the follow-up in December 2006. The results were similar, although the scarcity of events in the first five years of follow-up did not allow having statistically significant associations.

**Table 3. Association between temporary employment and mortality by specific sector. Men 2001-2015**

	N	N death	Overall mortality HR	95% CI	N death	CV mortality HR	95% CI	N death	AC mortality HR	95% CI
<b>Overall</b>	320,654	14290	1.16	1.09 1.24	3793	1.29	1.14 1.45	884	1.27	1.04 1.57
<b>Sector of employment</b>										
<b>Fishing and agriculture</b>	3,927	271	0.83	0.56 1.22	67	1.41	0.73 2.71	19	0.92	0.26 3.29
Agriculture, hunting, forestry	3,620	250	0.84	0.57 1.26	65	1.38	0.72 2.67	17	0.69	0.15 3.12
Fishing, fish farming	307	21	0.68	0.08 5.97	2	-	- -	2	-	- -
<b>Industry</b>	44,568	1897	1.26	1.07 1.49	502	1.17	0.84 1.62	130	1.58	0.96 2.61
Coal mining, oil extraction	1,829	86	1.78	0.74 4.30	21	0.88	0.10 7.88	4	-	- -
Food industry	3,979	171	1.28	0.76 2.16	46	1.86	0.78 4.47	13	0.68	0.08 5.44
Textile, leather industry	2,035	107	0.72	0.35 1.50	36	1.30	0.45 3.80	5	-	- -
Wood, wood products industry, publishing	5,174	225	1.06	0.63 1.77	63	0.46	0.11 1.91	10	0.62	0.07 5.50
Refinery, pharmaceutical, chemical industry	5,959	211	1.09	0.62 1.92	53	1.02	0.34 3.05	14	1.37	0.27 6.87
Non-metal mineral industry	1,348	71	1.17	0.59 2.34	27	1.01	0.30 3.47	4	-	- -
Steel industry	17,755	728	1.34	1.04 1.71	187	0.85	0.48 1.52	64	2.01	1.04 3.87
Furniture industry	1,651	89	1.49	0.79 2.83	16	1.69	0.36 7.95	5	-	- -
Production, distribution of electricity, water	4,838	209	0.89	0.39 2.02	53	3.85	1.50 9.83	11	-	- -
<b>Building Constructions</b>	21,058	1047	1.29	1.08 1.54	290	1.31	0.94 1.83	86	1.19	0.67 2.10
<b>Sales and Transports</b>	79,626	3265	1.12	0.98 1.27	859	1.33	1.05 1.68	225	1.10	0.74 1.64
Sale, maintenance, repair of motor vehicles,	8,449	345	0.91	0.61 1.37	77	1.76	0.89 3.48	20	1.31	0.37 4.61
Wholesale trade, intermediaries of trade	7,795	261	1.10	0.71 1.70	66	0.85	0.34 2.15	16	4.48	1.52 13.25
Retail trade	13,546	547	1.10	0.84 1.44	130	1.72	1.07 2.77	40	0.62	0.22 1.79
Hotels, camping, bars, restaurants	13,147	561	1.12	0.86 1.46	154	1.09	0.65 1.84	51	1.66	0.85 3.25
Transport	36,689	1551	1.14	0.92 1.43	432	1.31	0.87 1.97	98	0.59	0.26 1.33



Table 3. Continued

	N	N deaths	Overall mortality			N deaths	CV mortality			N deaths	AC mortality		
			HR	95% CI			HR	95% CI			HR	95% CI	
<b>Credit, insurances, and other services</b>	51,771	1806	1.11	0.89 1.37		476	1.20	0.80 1.81		88	0.95	0.42 2.17	
Credit, insurance, monetary, financial intermediation	23,179	1059	1.17	0.83 1.65		265	1.05	0.51 2.16		49	1.19	0.32 4.37	
IT, research, development	18,870	383	0.57	0.33 1.00		114	0.34	0.08 1.37		22	0.47	0.06 3.74	
Professional consulting, real estate, rental	9,722	364	1.33	0.96 1.84		97	1.98	1.13 3.49		17	1.05	0.28 3.94	
<b>Social services</b>	117,812	5910	1.11	1.00 1.25		1573	1.26	1.03 1.55		329	1.36	0.94 1.97	
Local, national, public administration	66,677	3245	1.20	1.01 1.43		879	1.56	1.15 2.11		174	1.68	0.95 3.00	
Public, private education	15,276	897	1.27	0.97 1.67		230	1.54	0.93 2.55		43	0.87	0.30 2.52	
Health, social assistance	19,331	1003	0.88	0.66 1.17		277	0.91	0.53 1.57		62	0.67	0.21 2.21	
Political, trade union organizations	2,404	111	1.01	0.52 1.95		33	0.77	0.18 3.36		3	-	- -	
Recreational, cultural, sports activities	5,143	217	1.17	0.84 1.64		49	1.48	0.75 2.95		21	1.25	0.48 3.24	
Other service activities	4,939	211	1.18	0.75 1.85		46	0.94	0.33 2.68		18	2.33	0.73 7.40	
Domestic services	4,042	226	0.43	0.22 0.84		59	0.54	0.17 1.73		8	-	- -	
<b>International organizations</b>	1,892	94	0.78	0.33 1.83		26	1.09	0.24 4.85		7	-	- -	
HR adjusted for age													
CV cardiovascular													
AC accidental													

## DISCUSSION

Our results, based on a cohort of 597,834 employees, showed that having temporary contracts, compared to permanent ones, was associated with greater overall mortality risk in men but not in women. Mortality risks for temporary employees compared to permanent ones varied widely among different economic sectors. In men, we found higher risks in industry, building constructions, and social services sectors. In women, we found a higher risk in temporary compared to permanent workers only in sales and transports, mainly due to the strong association in the retail sector.

Differences between men and women were consistent for all considered causes of death and all economic sectors, except for sales and transports. There was considerable agreement between our results and previously published works regarding gender differences in the association between temporary contract and mortality. All the studies that stratified the analysis by gender found stronger associations in men than in women.[11-13]

For both men and women, the analysis of the association between temporary contract and mortality by sector of employment showed that most hazard ratios were greater than one. The risk for temporary employment was generally higher in sectors where less-skilled employees were more represented. Particularly in men, mortality was higher in sectors in which manual workers are predominant, such as industry and building constructions. One possible explanation could be that temporary workers employed in these sectors might be exposed to specific risks. Indeed, it is well known that employees working in specific economic sectors may be exposed to hazards and behavioral risks.[18,19] Furthermore, it is well established that, compared to permanent workers, temporary ones experience worse job quality,[20] and less use of personal protective equipment,[21] as well as less training and information about work environment and occupational risks.[22,23] Therefore, it could be hypothesized that these conditions impact mostly on temporary workers employed in specific sectors. In men, the association between temporary contracts and mortality was also evident in the sector of public administration.

A study conducted in Rome that analyzed the association between occupational status and mortality found higher mortality for cardiovascular disease and accidental causes in unemployed

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compared to employees.[17] Possible explanations provided by the authors are the prevalence of risky behaviors and habits (smoking or unhealthy diet) among unemployed, as well as the “status syndrome” theory that hypothesizes a link between lack of control and low social participation and disease risk. Temporary workers may share some of the same risky conditions of unemployed. A study found higher mortality in temporary compared to permanent workers for smoking and alcohol related cancers.[13] Furthermore, temporary workers can frequently experience periods of unemployment. Therefore, some of the risk factors of unemployment may have an impact also on temporary employment regarding cardiovascular and accidental mortality.

In general, temporary employment includes all forms of no open-ended contracts, such as fixed-term, temporary-agency, apprenticeship, seasonal, and casual works. The majority of these forms of employment may share different dimensions of precariousness, such as job insecurity, low wages, and social protection. All these factors are proposed as possible pathways linking temporary employment to negative health outcomes.[24] Nevertheless, a general negative impact was found on self-reported health,[2,25] although some studies are not consistent with this result.[26] There is a large consensus regarding the negative impact on mental health,[10] while for occupational injuries a recent meta-analysis showed no conclusive results.[27] Studies on mortality showed that the strength of the association varies with the type of temporary contract,[11] and that the risk is higher only for involuntary and not satisfied temporary workers.[14]

Globally, the studies on the association between temporary employment and mortality are limited and they were conducted all in North European countries. It is noteworthy that the impact of precariousness on health outcomes could depend also on contextual factors, such as the percentage of precarious employment and the social policies in the country.[28] Our study was the first to analyze the association between mortality and type of contract in Italy. According to the Italian Institute of Statistics, the percentage of temporary employment in Italy has increased in the last decades, ranging from a mean of 11.8% of the total dependent employee in 2004 to a mean of 17.0% in 2019.[29] Rising in temporary contracts was mainly explained by the structural reforms that increased flexibility in the labor market over the last decades,[30] as well as the Great Recession in 2008. Regarding gender differences in contracts type, our data based on Rome population are in agreement with national data, with a higher rate of temporary workers in

women than in men. In the population of Rome, the higher percentage of women with temporary contracts in our study can be added to previous results showing that women had a higher percentage of unemployment than men.[17]

Our study had some limitations. First, the type of contract was evaluated only at the beginning of the follow-up, i.e. 2001. However, there is substantial agreement between the principal and the sensitivity analyses, although the smaller number of deaths in the latter reduced the significance of the associations. Second, there was a lack of information on employees' health and behavioral risk factors. In particular, it is possible that the health status influenced the probability of having a permanent employment, determining a selection bias. Third, since the cohort was followed from 2001 to 2015, the data could be considered dated. However, the 2001 census was the last census that collected information on job and type of contract for the whole population. Therefore, it is the last census that allows analyzing different economic sectors separately. Finally, since 84,084 subjects migrated during the follow-up, the censoring for migration from Rome could have introduced a bias. However, a previous study on education and mortality used an inverse probability approach to account for migration and did not find differences in results from the traditional survival analysis.[16]

In conclusion, our results point out that temporary contracts should be considered as an important determinant of health in particular for workers employed in specific economic sectors. Furthermore, the well-known heterogeneity in the temporary employees was confirmed by our study throughout the different economic sectors. These results highlight the importance to perform studies on health outcomes in temporary workers focusing on different economic sectors to better understand individual, work-related and contextual factors linking temporary contracts and mortality risk. Future research should be conducted to confirm these results and to evaluate differences among countries with different labor market settings.

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**Contributors**

AN and GC conceived the study, drafted the manuscript and were responsible for the final version of the manuscript. GC handled the permissions and data collection. AN, LDB and GC handled the data management and analyses. NA and MD critically revised the manuscript for important intellectual content. All authors reviewed, read and approved the final manuscript.

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**Competing interests**

None declared.

**Patient consent for publication**

Not required.

**Data availability statement**

Data reported in the manuscript are not publicly available because of stringent legal restrictions regarding privacy policy on personal information in Italy (national legislative decree on privacy policy n. 196/30 June 2003). All data presented in the study are stored by the Department of Epidemiology-Lazio Regional Health Service and only the research team and related Institutions have access to the data. Interested researchers can contact the following persons to request the data: Nera Agabiti (n.agabiti@deplazio.it).

**Ethics approval**

The Rome Longitudinal Study is approved by the Italian Data Protection Authority (G.U. 16-07-2019 n.165. pag.26. available at:  
[https://www.gazzettaufficiale.it/ricerca/pdf/serie\\_generale/3/0/0?reset=true](https://www.gazzettaufficiale.it/ricerca/pdf/serie_generale/3/0/0?reset=true)).

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## Supplemental Material

### Temporary employment and mortality in a large administrative cohort

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**Supplementary Table 1. Characteristics by occupational sector in men, Rome 2001.**

Men	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
<b>Fishing and agriculture</b>	3,927	14.7	7.6	9.8	43.7 (10.9)	271	24.7	7.0
Agriculture, haunting, forestry	3620	14.9	7.5	9.6	44.0 (10.9)	250	26.0	6.8
Fishing, fish farming	307	12.4	8.1	11.4	40.9 (10.6)	21	9.5*	9.5*
<b>Industry</b>	44,568	9.7	18.2	4.8	42 (9.9)	1,897	26.5	6.9
Coal mining, oil extraction	1,829	6.2	29.3	4.6	45.7 (10)	86	24.4	4.7*
Food industry	3,979	10.0	12.0	5.2	41.7 (9.9)	171	26.9	7.6
Textile, leather industry	2,035	14.3	9.0	7.4	41.3 (10.5)	107	33.6	4.7*
Wood, wood products industry. publishing	5,174	9.5	9.2	3.6	42.2 (9.5)	225	28.0	4.4
Refinery, pharmaceutical, chemical industry	5,959	8.8	35.1	4.9	42.5 (9.8)	211	25.1	6.6
Non-metal mineral industry	1,348	13.8	7.8	7.6	41.5 (10.2)	71	38.0	5.6*
Steel industry	17,755	10.6	17.8	4.8	41.1 (9.8)	728	25.7	8.8
Furniture industry	1,651	13.3	6.8	7.6	41.1 (10.8)	89	18.0	5.6*
Production, distribution of electricity, water and gas	4,838	4.9	19.6	2.6	44 (9)	209	25.4	5.3
<b>Building Constructions</b>	21,058	14.2	10.2	7.1	41.5 (10.7)	1,047	27.7	8.2
<b>Sales and Transport</b>	79,626	11.0	9.4	5.6	41.1 (10.1)	3,265	26.3	6.9
Sale, maintenance, repair of motor vehicles, sale of fuel	8,449	11.6	6.1	4.8	40.3 (10.3)	345	22.3	5.8
Wholesale trade, intermediaries of trade	7,795	11.4	8.4	5.2	39.9 (10)	261	25.3	6.1
Retail trade	13,546	13.0	5.9	5.1	39.4 (10.4)	547	23.8	7.3
Hotels, camping, bars, restaurants	13,147	13.8	4.8	13.5	39.5 (10.2)	561	27.5	9.1
Transport	36,689	9.1	13.4	3.2	42.7 (9.8)	1,551	27.9	6.3
<b>Credit, insurances and other services</b>	51,771	9.2	32.4	3.1	41 (9.9)	1,806	26.4	4.9
Credit, insurance, monetary, financial intermediation	23,179	4.6	29.5	2.6	45 (9.3)	1,059	25.0	4.6
IT, research, development	18,870	11.4	35.0	3.0	36.9 (8.6)	383	29.8	5.7
Professional consulting, real estate, rental	9,722	15.6	34.1	4.4	39.1 (10.1)	364	26.6	4.7
<b>Social services</b>	117,812	7.8	29.7	4.2	44.2 (9.9)	5,910	26.6	5.6

**Supplementary Table 1. Continued**

	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
Local, national, public administration	66,677	4.5	21.0	2.7	44 (9.8)	3,245	27.1	5.4
Public, private education	15,276	11.6	62.9	4.3	47.3 (9.6)	897	25.6	4.8
Health, social assistance	19,331	8.5	45.7	3.3	44.7 (9.4)	1,003	27.6	6.2
Political, trade union organizations	2,404	11.9	35.9	3.0	43.9 (10)	111	29.7	2.7*
Recreational, cultural, sports activities	5,143	27.1	22.8	5.5	41 (10)	217	22.6	9.7
Other service activities	4,939	12.2	5.5	4.9	40.3 (9.8)	211	21.8	8.5
Domestic services	4,042	11.5	4.9	32.1	42.9 (10.1)	226	26.1	3.5*
<b>International organizations</b>	1,892	12.2	32.2	20.6	44.7 (9.9)	94	27.7	7.4*

\* Less than 10 deaths

CV cardiovascular

AC accidental

Supplementary Table 2. Characteristics by occupational sector in women, Rome 2001.

Women	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
<b>Fishing and agriculture</b>	3,032	20.4	8.4	12.0	43.7 (10.3)	114	23.7	0.9*
Agriculture, haunting, forestry	2,917	20.3	7.9	12.2	43.9 (10.2)	113	24.0	0.9*
Fishing, fish farming	115	25.2	20.9	6.1	40.1 (10.9)	1	0.0	0.0
<b>Industry</b>	19,721	13.9	18.9	7.3	39.8 (9.4)	423	16.5	5.7
Coal mining, oil extraction	964	9.2	20.4	4.9	43 (9)	19	5.3*	0.0
Food industry	1,797	15.2	13.5	9.1	39.4 (9.9)	36	25.0*	11.1*
Textile, leather industry	3,553	18.7	6.3	9.8	40.1 (10.1)	96	16.7	4.2*
Wood, wood products industry, publishing	2,313	13.1	17.8	4.5	40.2 (9)	47	12.8*	4.3*
Refinery, pharmaceutical, chemical industry	3,360	13.0	37.6	7.2	38.6 (8.7)	61	21.3	9.8*
Non-metal mineral industry	393	16.5	13.0	11.2	39.3 (9.7)	13	0.0	15.4*
Steel industry	5,137	14.0	17.9	7.3	39.5 (9.3)	105	15.2	3.8*
Furniture industry	583	17.5	10.5	9.3	38.2 (9.6)	12	16.7*	8.3*
Production, distribution of electricity, water and gas	1,621	5.6	22.2	3.8	41.6 (8.6)	34	20.6*	2.9*
<b>Building Constructions</b>	3,612	14.3	15.9	4.1	38 (9)	74	16.2	4.1*
<b>Sales and Transport</b>	51,334	14.6	11.9	5.7	38.3 (9.5)	980	13.5	4.7
Sale, maintenance, repair of motor vehicles, sale of fuel	3,241	14.9	10.9	4.4	38.2 (9.5)	68	7.4*	5.9*
Wholesale trade, intermediaries of trade	5,755	13.3	9.6	5.3	37.7 (9.1)	105	16.2	5.7*
Retail trade	16,323	15.9	6.8	5.3	37.8 (9.9)	317	14.2	4.4
Hotels, camping, bars, restaurants	10,361	16.8	5.5	8.6	38.4 (9.8)	215	15.3	5.1
transport	15,654	12.0	22.6	4.7	39 (9.1)	275	11.6	4.0
<b>Credit, insurances and other services</b>	42,745	14.0	25.6	3.9	37.6 (8.8)	727	12.2	4.5
Credit, insurance, monetary, financial intermediation	16,469	8.3	23.2	3.6	40.4 (8.8)	359	13.1	3.1
IT, research, development	10,517	16.5	37.6	3.5	35.2 (7.5)	134	8.2	6.0*
Professional consulting, real estate, rental	15,759	18.2	20.1	4.4	36.4 (8.7)	234	13.2	6.0
<b>Social services</b>	154,755	12.5	33.0	6.3	43.3 (9.3)	4,493	14.8	3.4

**Supplementary Table 1. Continued**

	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
Local, national, public administration	54,091	5.9	25.3	3.1	44.3 (8.6)	1.676	15.0	4.3
Public, private education	45,229	16.7	50.8	4.6	45.2 (9.2)	1.416	13.4	2.5
Health, social assistance	31,890	11.7	34.2	4.8	41.3 (9.3)	832	14.9	3.7
Political, trade union organizations	3,618	12.9	25.4	3.9	40.9 (9)	87	17.2	1.1*
Recreational, cultural, sports activities	5,433	31.2	31.9	6.0	38.8 (9.4)	117	9.4	4.3*
Other service activities	5,473	17.3	6.4	5.4	37.9 (9.9)	127	18.1	2.4*
Domestic services	9,021	18.8	5.5	40.4	42.4 (10.1)	238	21.0	3.4*
<b>International organizations</b>	1,981	17.6	41.5	39.0	43.6 (9.4)	35	5.7*	0.0

\* Less than 10 deaths

CV cardiovascular

AC accidental

Table S3. Association between temporary employment and mortality in men and women. Rome 2001-2015

	Men									Women								
	Overall mortality			CV mortality			AC mortality			Overall mortality			CV mortality			AC mortality		
	HR	95% CI		HR	95% CI		HR	95% CI		HR	95% CI		HR	95% CI		HR	95% CI	
HR adjusted for age and level of education																		
Overall	1.13	1.06	1.20	1.25	1.11	1.41	1.31	1.06	1.61	1.01	0.93	1.10	0.97	0.77	1.22	1.35	0.95	1.93
Sector of employment																		
Fishing and agriculture	0.85	0.57	1.25	1.33	0.68	2.59	1.02	0.28	3.69	0.67	0.39	1.18	0.47	0.14	1.57	-	-	-
Industry	1.21	1.02	1.42	1.11	0.80	1.54	1.61	0.98	2.64	0.98	0.71	1.36	1.52	0.76	3.05	2.19	0.80	6.02
Building Constructions	1.23	1.03	1.46	1.22	0.87	1.70	1.21	0.69	2.14	0.91	0.37	2.22	4.79	0.83	27.5	-	-	-
Sales and Transport	1.08	0.95	1.23	1.27	1.00	1.61	1.10	0.74	1.64	1.23	1.01	1.50	1.29	0.77	2.13	1.53	0.70	3.37
Credit, insurances and other services	1.09	0.88	1.35	1.20	0.79	1.81	0.98	0.43	2.24	0.88	0.67	1.17	0.80	0.34	1.88	0.96	0.31	2.90
Social services	1.13	1.01	1.26	1.29	1.05	1.59	1.38	0.95	2.00	0.99	0.89	1.11	0.82	0.60	1.13	1.27	0.78	2.06
International organizations	0.70	0.29	1.71	0.71	0.14	3.49	3.03	0.38	24.27	1.00	0.33	3.07	5.96	0.19	183.7	1.00	1.00	1.00
HR adjusted for age, level of education, and place of birth																		
Overall	1.13	1.06	1.21	1.25	1.11	1.42	1.31	1.07	1.61	1.02	0.93	1.11	0.96	0.77	1.21	1.36	0.96	1.94
Sector of employment																		
Fishing and agriculture	0.94	0.62	1.40	1.54	0.77	3.09	1.08	0.27	4.34	0.78	0.44	1.37	0.54	0.16	1.83	-	-	-
Industry	1.21	1.03	1.43	1.09	0.78	1.52	1.65	1.00	2.72	0.98	0.71	1.37	1.51	0.73	3.11	1.95	0.69	5.57
Building Constructions	1.22	1.02	1.46	1.20	0.85	1.69	1.26	0.71	2.24	1.12	0.42	3.01	3.95	0.58	27.1	-	-	-
Sales and Transport	1.08	0.95	1.23	1.27	1.00	1.61	1.10	0.74	1.64	1.24	1.02	1.51	1.28	0.77	2.14	1.54	0.70	3.41
Credit, insurances and other services	1.11	0.89	1.38	1.23	0.81	1.86	1.00	0.44	2.28	0.91	0.68	1.20	0.89	0.38	2.10	0.96	0.31	2.92
Social services	1.13	1.01	1.27	1.30	1.06	1.60	1.39	0.96	2.02	0.99	0.89	1.11	0.82	0.59	1.12	1.27	0.78	2.07
International organizations	0.63	0.23	1.76	0.41	0.04	3.88	-	-	-	1.18	0.34	4.10	2.21	0.04	112.9	-	-	-

CV cardiovascular

AC accidental

**Table S4. Association between temporary employment and mortality in men and women. Rome, 2001-2006**

	N	Overall mortality			N	CV mortality			N	AC mortality		
	deaths	HR	95% CI		deaths	HR	95% CI		deaths	HR	95% CI	
<b>Men</b>												
Overall	3,657	1.13	1.00	1.28	1,003	1.31	1.04	1.65	345	1.11	0.79	1.56
Sector of employment												
Fishing and agriculture	66	1.40	0.72	2.69	14	3.25	1.00	10.6	6	1.12	0.13	10.03
Industry	477	1.18	0.85	1.63	161	1.40	0.82	2.37	52	1.12	0.48	2.61
Building Constructions	297	1.14	0.81	1.61	90	1.31	0.73	2.38	36	1.13	0.46	2.75
Sales and Transport	836	1.16	0.90	1.48	230	1.25	0.79	2.00	91	0.90	0.47	1.75
Credit, insurances and other services	439	1.42	0.96	2.09	110	2.07	1.03	4.14	37	1.41	0.50	4.00
Social services	1,517	0.92	0.73	1.17	391	0.85	0.52	1.39	122	1.01	0.52	1.97
International organizations	25	0.86	0.20	3.76	7	1.61	0.17	14.82	1	-	-	-
<b>Women</b>												
Overall	1,638	1.01	0.84	1.20	222	1.16	0.74	1.83	94	1.61	0.93	2.77
Sector of employment												
Fishing and agriculture	33	0.95	0.39	2.35	5	-	-	-	1	-	-	-
Industry	100	0.86	0.43	1.71	14	1.70	0.37	7.68	12	0.70	0.09	5.52
Building Constructions	19	1.31	0.29	5.94	2	16.8	1.03	274.5	-	-	-	-
Sales and Transport	245	1.38	0.95	2.00	36	1.05	0.37	3.02	14	2.31	0.63	8.43
Credit, insurances and other services	175	0.82	0.46	1.46	20	1.84	0.51	6.63	16	0.48	0.06	3.83
Social services	1,060	0.93	0.73	1.18	145	1.02	0.55	1.91	51	1.93	0.95	3.95
International organizations	6	1.18	0.11	13.3	-	-	-	-	-	-	-	-
HR adjusted for age												
CV cardiovascular												
AC accidental												



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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	5
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5, 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	6, 7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6, 7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6, 7
		(b) Describe any methods used to examine subgroups and interactions	7
		(c) Explain how missing data were addressed	5
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	5, 17
		(e) Describe any sensitivity analyses	7

Continued on next page

**Results**

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7, 8
		(b) Indicate number of participants with missing data for each variable of interest	-
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	7
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	7
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10, 12
		(b) Report category boundaries when continuous variables were categorized	9
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10, 12

**Discussion**

Key results	18	Summarise key results with reference to study objectives	15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15, 16, 17
Generalisability	21	Discuss the generalisability (external validity) of the study results	16, 17

**Other information**

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18
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\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Differences in mortality between temporary and permanent workers: results from the Rome Longitudinal Study

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# **Differences in mortality between temporary and permanent workers: results from the Rome Longitudinal Study**

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**ABSTRACT**

**Objective**

Precarious employment is characterized by instability, lack of protection, and economic vulnerability. The objective of this study was to assess the association between temporary contracts and mortality.

**Design**

Cohort study

**Setting**

Rome, Italy

**Participants**

All employees, aged 25-65 years, from the Rome Longitudinal Study, followed from 21 Oct 2001 to the first date among death, migration from Rome, or 31 Dec 2015.

Primary and secondary outcome measures

We investigated all-cause, cardiovascular, and accidental mortality. We considered gender, age, place of birth, education, temporary vs. permanent contract, and sector of employment. We used Cox models to investigate the association between type of contract and total, cardiovascular and accidental mortality in men and women, overall and by employment sector.

**Results**

We analyzed 597,834 subjects. The proportion of temporary contracts varied by gender (9.6% in men and 13.3% in women) and by employment sector, ranging from 4.5% (public administration) to 27% (recreational, cultural, sports activities) in men. During the study period 21,136 subjects died. Men with temporary contracts, compared to those with permanent positions, had greater overall mortality risk (HR=1.16, 95%CI: 1.09-1.24), cardiovascular mortality (HR=1.29, 95%CI: 1.14-1.45), and accidental mortality (HR=1.27, 95%CI: 1.04-1.57). In men, the association varied widely among different economic sectors, with greater risks in the industry, building constructions, and social services sectors. In women, there was no evidence of association between temporary contracts and mortality. A statistically significant association between temporary contracts and mortality in women was found in the sector of sales and transports only.

**Conclusions**

Temporary work should be considered a determinant of health, particularly for specific economic sectors.

**Keywords:** temporary employment, longitudinal study, mortality, vulnerability.

### Strengths and limitations of this study

- The study was based on 597,834 employees aged between 25 and 65 years residents in a metropolitan area, followed for 14 years.
- Census information linked to health data allowed a detailed analysis of health outcomes related to temporary work.
- The information on the sector of employment allowed to investigate health outcomes related to temporary work in specific sectors.
- The lack of information about job histories was a strong limit of our study.
- There was a lack of information on employees' health and behavioral risk factors.

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**INTRODUCTION**

During the last decades, increased flexibility in the labor market led to the spread of various forms of non-standard and precarious employment in Europe.[1] Due to the growth of evidence on the potential implications on health status, precariousness has been suggested as an emerging social determinant of health.[2] Some studies showed a social gradient in precarious contracts regarding the educational level and job type.[3,4] In addition, a higher proportion of precarious contracts was reported among women,[5] young adults,[1] and migrants.[6]

Despite the growing body of research, some concerns remain about the definition of precarious employment. According to the seminal work of Rodgers and Rodgers,[7] precariousness is a complex construct that encompasses different dimensions involving employment instability and insecurity, lack of protection, and economic vulnerability. Although some multidimensional methods have been developed to assess precariousness,[8,9] in public health research, it is frequent to focus on a specific domain using a one-dimensional approach. Within these domains, temporary employment, an objective measure of precariousness, is one of the most investigated.[10]

Few studies analyzed the effect of type of contract on mortality, showing an association between temporary contracts and mortality in specific subgroups of workers.[11-14] However, all mortality studies were conducted in Nordic European countries, and none investigated the impact of temporary contracts among different economic sectors. As the rate of temporary contracts may vary widely among economic sectors, the latter were evaluated as confounding factors.[13] Due to the worse working conditions of temporary employees, it is reasonable to hypothesize a joint effect between sector-related and contract-related health risks. Therefore, analyzing the association between temporary contracts and mortality by employment sector could be more appropriate than adjusting for this variable.

In Italy, reforms in the labor market legislation followed the European trend. Changes in the legislation were carried out during the last decades, starting with the “Treu law” in 1997. This reform introduced temporary contracts and modified regulation of fixed-term contracts, producing more flexibility and consequently more instability in the labor market. Thus, this study



aimed to assess the association between temporary contracts and all-cause and cause-specific mortality among a cohort of employees between 2001 and 2015 in Rome. We hypothesized that the association between temporary contracts and mortality could be stronger in sectors characterized by manual work, where uncertainty due to the temporary contracts might be a proxy of precariousness more than in non-manual sectors. Also, temporary manual workers might use personal protective equipment less than workers with permanent positions.

## METHODS

### Study Design

We used the Rome Longitudinal Study, the administrative cohort of residents in Rome who filled in the 2001 population census. The study, which has been already described, included all subjects who were not living in institutions on the census reference day, 21 Oct 2001.[15-17] We followed the subjects using record-linkage procedures with administrative databases, under strict control to protect individual privacy. We used the Municipal Registry for vital status and migration and Mortality Registry for the cause of death (coded according to the International Classification of Disease, 9<sup>th</sup> Revision, ICD-9). The follow-up started on the census reference day and ended on the day of death, of migration from Rome, or 31 Dec 2015, whichever came first. The Rome Longitudinal Study was part of the National Statistical Program 2019 and was approved by the Italian Data Protection Authority.

### Setting and participants

Rome is the capital of Italy, and it is the largest Italian city with about 2.5 million inhabitants on a surface of 1,290 Km<sup>2</sup> at 2001 census.

In this study, we selected all employees aged 25-65 years at baseline (78% of the employed population).

### Patient and public involvement

Patient involvement in the study was not possible, as individual contact information was unavailable because of privacy restrictions. However, due to the topic's relevance, the purpose is to disseminate study results to both population and policy-makers, to implement health promotion and prevention strategies in temporary workers of specific economic sectors.

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**Outcomes**

We analyzed all-cause mortality, cardiovascular mortality (ICD-9 codes 390–459), and accidental mortality (ICD-9 codes 800–999).

**Temporary employment, sector of employment, and other variables**

The census included a large amount of information regarding the occupation for the population aged 15 years or more: occupational status, a binary variable identifying employees and self-employed, the sector of employment, and for employees only, the distinction between temporary and permanent contracts.

The sector of employment was categorized in 28 categories grouped in seven groups, named macro-sectors. Sectors were classified as in the 2001 Italian census by the Italian National Institute of Statistics (ISTAT).[18]

Among other census variables, we selected gender, date of birth, level of education (coded as low for junior high school or less, medium for high school, and high for university or more), and place of birth (Rome, Italy, and abroad).

**Statistical analyses**

We computed sex-specific crude mortality rates by age class, type of contract, level of education, and place of birth. We used Cox proportional hazard models to investigate the association between type of contact (temporary vs. permanent employee) and total and cause-specific mortality in men and women, overall and by employment sector. We used time of follow-up as time axis and stratified the baseline hazard function by age. We tested for interaction between temporary contract and employment sector using the log-likelihood ratio test.

**Additional analyses**

As additional analyses, we performed the Cox regression stratifying the baseline hazard function by age, level of education, and place of birth.

As a sensitivity analysis, we performed Cox proportional hazard models to investigate the association between type of contact and mortality until 31 December 2006, allowing only five years of follow-up, under the hypothesis that the information on temporary employment at 2001 census could be more reliable in the first years after the census.

Assuming that temporary workers are more likely to migrate in search of a better position, we used an inverse probability weighting approach to handle missing information on deaths due to lost to follow-up due to migration.[19] First, we estimated sex-stratified probability (P) of non-emigration as a function of age, education, type of contract, and place of birth using logistic regression models. Then, we estimated the probability (P') of non-emigration as a function of age only to calculate stabilized weights (W) as  $P'/P$ . Finally, we performed weighted Cox regression models on non-migrants using the weights W.

Since the type of contract might partly reflect the well-known health differences in occupational classes, we further analyzed the association between temporary employment and mortality for each occupational class, categorized as manual workers, sale or service workers, low-skill non-manual workers and high-skill non-manual workers.

## RESULTS

The cohort included in the study was composed by 597,834 employees aged between 25 and 65 years (53.6% men and 46.4% women), followed for a mean of 12.9 years resulting in a total of 7,712,058 person-years.

Table 1 shows the main socio-demographic characteristics, overall, and cause-specific mortality of the study population. The percentage of temporary workers was higher in the youngest age class (20.2% in men and 24.6% in women), in the lower educational level (10.2% in men and 13.3% in women) and in people born abroad (14.0% in men and 18.4% in women). Women had a higher proportion of temporary contracts than men (13.3% vs. 9.6%) and were more educated than men (26.5% vs. 21.9% high educational level). More than one-third of the employees were born outside Rome, and 4.8% of men and 6.1% of women were born abroad. In the period of interest, there were 21,136 deaths (35.1 and 18.8 per 10,000 person-years in men and women, respectively). In men and women, cardiovascular deaths accounted for 26.5% and 14.6% of all deaths, respectively, whereas accidental deaths for 6.2% in men and 3.8% in women. Accidental mortality was almost twice as high for temporary compared to permanent workers in both men (10.9% vs. 5.8%) and women (6.7% vs. 3.6%) (not shown in table).

Table 1. Characteristics of the study population

	N	%	% Temporary workers	Number of deaths	% CV Deaths	% AC Deaths	CMR
<b>Men</b>							
<b>Total</b>	320,654	100.0	9.6	14,290	26.5	6.2	35.1
<b>Age class</b>							
25-34	83,837	26.1	20.2	725	20.6	34.3	7.0
35-44	102,024	31.8	6.9	2,035	25.7	12.1	15.4
45-54	89,910	28.0	4.7	5,195	27.3	4.3	44.6
55-65	44,883	14.0	6.0	6,335	26.9	2.6	113.2
<b>Education</b>							
High	70,356	21.9	9.9	2,585	26.7	5.5	28.5
Medium	144,897	45.2	9.1	5,017	26.5	7.1	27.2
Low	105,401	32.9	10.2	6,688	26.5	5.8	50.5
<b>Place of birth</b>							
Rome	200,499	62.5	10.9	7,671	26.1	7.1	29.9
Italy	104,735	32.7	6.6	6,180	27.0	4.8	46.8
Abroad	15,420	4.8	14.0	439	28.0	9.1	23.6
<b>Women</b>							
<b>Total</b>	277,180	100.0	13.3	6,846	14.6	3.8	18.9
<b>Age class</b>							
25-34	80,257	29.0	24.6	421	11.4	15.4	4.1
35-44	93,520	33.7	11.3	1,344	11.5	5.1	10.8
45-54	75,688	27.3	6.3	2,816	13.2	3.1	28.0
55-65	27,715	10.0	6.9	2,265	18.7	1.9	62.9
<b>Education</b>							
High	73,511	26.5	15.0	1,551	12.5	3.6	16.0
Medium	140,773	50.8	12.4	2,918	12.7	4.4	15.8
Low	62,896	22.7	13.3	2,377	18.1	3.3	29.2
<b>Place of birth</b>							
Rome	176,768	63.8	14.4	3,909	13.6	4.2	16.8
Italy	83,400	30.1	10.2	2,603	15.7	3.1	23.9
Abroad	17,012	6.1	18.4	334	17.7	5.4	15.8

CV cardiovascular  
AC accidental  
CMR crude mortality rate per 10,000 person-years

Main characteristics by occupational sectors for men and women are shown in Supplementary Material. In men (Table S1), the macro-sector with the highest percentage of temporary employees was fishing and agriculture (14.7%). The sector with the highest proportion of

temporary workers was recreational, cultural, and sports activities, within the macro-category of social services, with 27.1%. Table S1 highlights the differences among sectors in terms of socioeconomic position and origins. The education sector had the highest proportion of highly educated employees (62.9%), followed by the health and social assistance sector (45.7%), whereas the sectors with the lowest proportion were hotels, bars, and restaurants (4.8%) and domestic services (4.9%). The proportion of foreigners varied among sectors, with the highest percentage in domestic services (32.1%) followed by international organizations (20.6%). Women showed higher percentages of temporary contracts than men in all macro-sectors (Table S2). In women, the macro-sectors with the highest rate of temporary employees were fishing and agriculture (20.4%), international organizations (17.6%), and sales and transport (14.6%). Conversely, the lowest proportion was in social services (12.5%). However, in this macro-sector, there was great variability, with the percentage of temporary workers ranging between 31.2% of recreational, cultural and sporting activities and 5.9% of local, national, and public administration.

Table 2 shows the association between temporary employment and mortality overall and by employment macro-sector in men and women. Age-adjusted Cox regression models showed greater overall mortality risk for temporary workers in men (HR 1.16, 95%CI 1.09-1.24) but not in women (HR 1.03, 95%CI 0.95-1.12). The likelihood ratio tests, comparing the models with and without the interaction term between type of contract and sector of employment, were statistically significant in both men ( $p = 0.04$ ) and women ( $p = 0.04$ ). Among macro-sectors, industry (HR 1.26, 95%CI 1.07-1.49), building constructions (HR 1.29, 95%CI 1.08-1.54), and social services (HR 1.11, 95%CI 1.00-1.25) showed greater overall mortality risks in men, whereas women had higher mortality in sales and transports sector (HR 1.23, 95%CI 1.01-1.49). Overall, in men, temporary workers had higher cardiovascular mortality in temporary than those with permanent positions (HR 1.29, 95%CI 1.14-1.45), particularly in the macro-sectors of sales and transports (HR 1.33, 95%CI 1.05-1.68) and social services (HR 1.26, 95%CI 1.03-1.55). In women, although the hazard ratios were greater than one in several macro-sectors, there was no evidence of an association between type of contract and cardiovascular mortality. Temporary workers had a higher risk of accidental mortality than workers in permanent positions in men (HR 1.27, 95%CI 1.04-1.57), but not in women (HR 1.34, 95%CI 0.94-1.91).

Table 3 shows the association between temporary employment and overall, cardiovascular, and accidental mortality in men by specific employment sector. There was an association with

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**Table 2. Association between temporary employment and mortality overall and by macro-sector of employment. Men and women, Rome 2001-2015**

	N	N deaths	Overall mortality			N deaths	CV mortality			N deaths	AC mortality		
			HR	95% CI			HR	95% CI			HR	95% CI	
<b>Men</b>													
Overall	320,654	14,290	1.16	1.09	1.24	3,793	1.29	1.14	1.45	884	1.27	1.04	1.57
Macro-sector of employment*													
Fishing and agriculture	3,927	271	0.83	0.56	1.22	67	1.41	0.73	2.71	19	0.92	0.26	3.29
Industry	44,568	1,897	1.26	1.07	1.49	502	1.17	0.84	1.62	130	1.58	0.96	2.61
Building Constructions	21,058	1,047	1.29	1.08	1.54	290	1.31	0.94	1.83	86	1.19	0.67	2.10
Sales and Transports	79,626	3,265	1.12	0.98	1.27	859	1.33	1.05	1.68	225	1.10	0.74	1.64
Credit, insurances and other services	51,771	1,806	1.11	0.89	1.37	476	1.20	0.80	1.81	88	0.95	0.42	2.17
Social services	117,812	5,910	1.11	1.00	1.25	1,573	1.26	1.03	1.55	329	1.36	0.94	1.97
<b>Women</b>													
Overall	277,180	6,846	1.03	0.95	1.12	997	1.02	0.81	1.28	262	1.34	0.94	1.91
Macro-sector of employment*													
Fishing and agriculture	3,032	114	0.71	0.41	1.23	27	0.53	0.16	1.77	1	-	-	-
Industry	19,721	423	1.01	0.73	1.39	70	1.61	0.82	3.19	24	2.21	0.81	6.06
Building Constructions	3,612	74	0.89	0.38	2.10	12	3.56	0.86	14.7	3	-	-	-
Sales and Transports	51,334	980	1.23	1.01	1.49	132	1.31	0.79	2.16	46	1.57	0.72	3.45
Credit, insurances and other services	42,745	727	0.90	0.68	1.19	89	0.77	0.33	1.80	33	0.95	0.32	2.83
Social services	154,755	4,493	1.01	0.91	1.13	665	0.85	0.62	1.17	155	1.22	0.75	1.98

Hazard Ratios (HRs) adjusted for age

CV cardiovascular, AC accidental

\* International organizations sector, contributing with 94 and 35 deaths for men and women respectively, was not shown.

overall mortality, with higher risks in subjects with temporary compared to permanent contracts, in the steel industry sector (HR 1.34, 95%CI 1.04-1.71) and in the public administration (HR 1.20, 95%CI 1.01-1.43). Higher cardiovascular mortality risks were found in the sector of production and distribution of electricity, water, and gas (HR 3.85, 1.50-9.83), in the retail and trade sector (HR 1.72, 95%CI 1.07-2.77), in the sector which includes professional consulting, real estate, and rental (HR 1.98, 95%CI 1.13-3.49), and public administration (HR 1.56, 95%CI 1.15-2.11). There was a higher risk for accidental mortality in two sectors: steel industry (HR 2.01, 1.04-3.87) and wholesale trade and intermediaries of trade (HR 4.48, 1.52-13.25) with wide confidence intervals due to the small number of deaths. Since there was no evidence of an association between type of contract and overall mortality in women, we did not investigate the possible association in specific sectors.

Supplementary Table S3 shows the results from Cox regression models adjusted for age and level of education, and then for age, level of education, and place of birth. Adjusting for the level of education and place of birth slightly reduced the HR for all statistically significant results except for public service in men and sales and transport in women, which presented an increase.

The sensitivity analysis conducted with a follow-up from 2001 to 2006 confirmed the results on overall and cardiovascular mortality in men. Results on accidental mortality were based on 345 cases and were not statistically significant. Supplementary Table S4 shows the results of the association between temporary employment and overall mortality by macro-sectors ending the follow-up in December 2006. The results were similar, although the scarcity of events in the first five years of follow-up did not allow having statistically significant associations. There were no differences in HRs for overall and cause-specific mortality using the inverse probability approach: for overall mortality the HRs of temporary vs. permanent contracts were 1.17 (95%CI 1.10-1.25) and 1.04 (95%CI 0.95-1.14) for men and women, respectively.

Supplementary Table S5 shows the results of the association between temporary employment and overall mortality by type of work. Manual and sale or service workers with temporary contracts showed significantly higher overall mortality than those with permanent contracts (manual: HR 1.16; 95%CI 1.05-1.28; sale or service: HR 1.22; 95%CI 1.02-1.46). However, it should be noted that HRs > 1 were found in all occupational classes, although without reaching statistical significance. Furthermore, high-skill non-manual workers with temporary contracts showed significantly higher cardiovascular mortality compared to high-skill non-manual workers with permanent contracts (HR 1.34; 95%CI 1.06-1.70).

**Table 3. Association between temporary employment and mortality by specific sector. Men 2001-2015**

	N	N death	Overall mortality			N death	CV mortality			N death	AC mortality		
			HR	95% CI			HR	95% CI			HR	95% CI	
<b>Overall</b>	320,654	14,290	1.16	1.09 1.24		3,793	1.29	1.14 1.45		884	1.27	1.04 1.57	
<b>Sector of employment*</b>													
<b>Fishing and agriculture</b>	3,927	271	0.83	0.56 1.22		67	1.41	0.73 2.71		19	0.92	0.26 3.29	
Agriculture, hunting, forestry	3,620	250	0.84	0.57 1.26		65	1.38	0.72 2.67		17	0.69	0.15 3.12	
Fishing, fish farming	307	21	0.68	0.08 5.97		2	-	- -		2	-	- -	
<b>Industry</b>	44,568	1,897	1.26	1.07 1.49		502	1.17	0.84 1.62		130	1.58	0.96 2.61	
Coal mining, oil extraction	1,829	86	1.78	0.74 4.30		21	0.88	0.10 7.88		4	-	- -	
Food industry	3,979	171	1.28	0.76 2.16		46	1.86	0.78 4.47		13	0.68	0.08 5.44	
Textile, leather industry	2,035	107	0.72	0.35 1.50		36	1.30	0.45 3.80		5	-	- -	
Wood, wood products industry, publishing	5,174	225	1.06	0.63 1.77		63	0.46	0.11 1.91		10	0.62	0.07 5.50	
Refinery, pharmaceutical, chemical industry	5,959	211	1.09	0.62 1.92		53	1.02	0.34 3.05		14	1.37	0.27 6.87	
Non-metal mineral industry	1,348	71	1.17	0.59 2.34		27	1.01	0.30 3.47		4	-	- -	
Steel industry	17,755	728	1.34	1.04 1.71		187	0.85	0.48 1.52		64	2.01	1.04 3.87	
Furniture industry	1,651	89	1.49	0.79 2.83		16	1.69	0.36 7.95		5	-	- -	
Production, distribution of electricity, water	4,838	209	0.89	0.39 2.02		53	3.85	1.50 9.83		11	-	- -	
<b>Building Constructions</b>	21,058	1,047	1.29	1.08 1.54		290	1.31	0.94 1.83		86	1.19	0.67 2.10	
<b>Sales and Transports</b>	79,626	3,265	1.12	0.98 1.27		859	1.33	1.05 1.68		225	1.10	0.74 1.64	
Sale, maintenance, repair of motor vehicles,	8,449	345	0.91	0.61 1.37		77	1.76	0.89 3.48		20	1.31	0.37 4.61	
Wholesale trade, intermediaries of trade	7,795	261	1.10	0.71 1.70		66	0.85	0.34 2.15		16	4.48	1.52 13.25	
Retail trade	13,546	547	1.10	0.84 1.44		130	1.72	1.07 2.77		40	0.62	0.22 1.79	
Hotels, camping, bars, restaurants	13,147	561	1.12	0.86 1.46		154	1.09	0.65 1.84		51	1.66	0.85 3.25	
Transport	36,689	1,551	1.14	0.92 1.43		432	1.31	0.87 1.97		98	0.59	0.26 1.33	



Table 3. *Continued*

	N	N deaths	Overall mortality			N deaths	CV mortality			N deaths	AC mortality		
			HR	95% CI			HR	95% CI			HR	95% CI	
<b>Credit, insurances, and other services</b>	51,771	1,806	1.11	0.89 1.37		476	1.20	0.80 1.81		88	0.95	0.42 2.17	
Credit, insurance, monetary, financial intermediation	23,179	1,059	1.17	0.83 1.65		265	1.05	0.51 2.16		49	1.19	0.32 4.37	
IT, research, development	18,870	383	0.57	0.33 1.00		114	0.34	0.08 1.37		22	0.47	0.06 3.74	
Professional consulting, real estate, rental	9,722	364	1.33	0.96 1.84		97	1.98	1.13 3.49		17	1.05	0.28 3.94	
<b>Social services</b>	117,812	5,910	1.11	1.00 1.25		1573	1.26	1.03 1.55		329	1.36	0.94 1.97	
Local, national, public administration	66,677	3,245	1.20	1.01 1.43		879	1.56	1.15 2.11		174	1.68	0.95 3.00	
Public, private education	15,276	897	1.27	0.97 1.67		230	1.54	0.93 2.55		43	0.87	0.30 2.52	
Health, social assistance	19,331	1,003	0.88	0.66 1.17		277	0.91	0.53 1.57		62	0.67	0.21 2.21	
Political, trade union organizations	2,404	111	1.01	0.52 1.95		33	0.77	0.18 3.36		3	-	- -	
Recreational, cultural, sports activities	5,143	217	1.17	0.84 1.64		49	1.48	0.75 2.95		21	1.25	0.48 3.24	
Other service activities	4,939	211	1.18	0.75 1.85		46	0.94	0.33 2.68		18	2.33	0.73 7.40	
Domestic services	4,042	226	0.43	0.22 0.84		59	0.54	0.17 1.73		8	-	- -	

HR adjusted for age

CV cardiovascular

AC accidental

\* International organizations sector, contributing with 94 and 35 deaths for men and women respectively, was not shown.

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**DISCUSSION**

Our results, based on a cohort of 597,834 employees, showed that having temporary contracts, compared to permanent ones, was associated with greater overall mortality risk in men but not in women. Mortality risks for temporary employees compared to permanent ones varied widely among different economic sectors. In men, we found higher risks in the industry, building constructions, and social services sectors. In women, we found a higher risk in temporary compared to permanent workers only in sales and transports, mainly due to the strong association in the retail sector.

Differences between men and women were consistent for all considered causes of death and all economic sectors, except for sales and transport. There was considerable agreement between our results and previously published works regarding gender differences in the association between temporary contracts and mortality. All the studies that stratified the analysis by gender found stronger associations in men than in women.[11-13]

For both men and women, the analysis of the association between temporary contracts and mortality by sector of employment showed that most hazard ratios were greater than one. The risk for temporary employment was generally higher in sectors where less-skilled employees were more represented. Particularly in men, mortality was higher in sectors in which manual workers are predominant, such as industry and building constructions. One possible explanation could be that temporary workers employed in these sectors might be exposed to specific risks. Indeed, it is well known that employees working in specific economic sectors may be exposed to hazards and behavioral risks.[20,21] Furthermore, it is well established that, compared to permanent workers, temporary ones experience worse job quality,[22] and less use of personal protective equipment,[23] as well as less training and information about the work environment and occupational risks.[24,25] Therefore, it could be hypothesized that these conditions impact mostly on temporary workers employed in specific sectors. In men, the association between temporary contracts and mortality was also evident in the sector of public administration. This association is somewhat difficult to explain. It has to be considered that, due to the high number of comparisons, it could be possible that some of the associations can be due to chance.

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3 A study conducted in Rome that analyzed the association between occupational status and  
4 mortality found higher mortality for cardiovascular disease and accidental causes in unemployed  
5 compared to employees.[17] Possible explanations provided by the authors are the prevalence of  
6 risky behaviors and habits (smoking or unhealthy diet) among the unemployed and the “status  
7 syndrome” theory that hypothesizes a link between lack of control and low social participation and  
8 disease risk. Temporary workers may share some of the same risky conditions of unemployed. A  
9 study found higher mortality in temporary compared to permanent workers for smoking and  
10 alcohol-related cancers.[13] Furthermore, temporary workers can frequently experience periods  
11 of unemployment. Therefore, some of the risk factors of unemployment may have an impact also  
12 on temporary employment regarding cardiovascular and accidental mortality.  
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23 In general, temporary employment includes all forms of no open-ended contracts, such as  
24 fixed-term, temporary-agency, apprenticeship, seasonal, and casual works. Most of these forms of  
25 contracts may share different dimensions of precariousness, such as job insecurity, low wages, and  
26 social protection. These factors are proposed as possible pathways linking temporary employment  
27 to adverse health outcomes.[26] Nevertheless, a negative impact was generally found on self-  
28 reported health,[2,27] although some studies are not consistent with this result.[28] There is a  
29 large consensus regarding the negative impact on mental health,[10] while for occupational  
30 injuries, a recent meta-analysis showed no conclusive results.[29] Studies on mortality showed  
31 that the strength of the association varies with the type of temporary contract,[11] and that the  
32 risk is higher only for involuntary and not satisfied temporary workers.[14]  
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43 It should be considered that type of contract might partly reflect the well-known health  
44 differences in occupational class. However, the additional analysis showed differences for both  
45 manual and high-skill non-manual workers. Therefore, temporary contracts and job type seem to  
46 assess distinct socioeconomic job-related domains, with temporary contracts showing different  
47 impacts on mortality risk among the occupational classes.  
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54 Globally, the studies on the association between temporary employment and mortality are  
55 limited, and they were all conducted in North European countries. It is noteworthy that the impact  
56 of precariousness on health outcomes could also depend on contextual factors, such as the  
57 percentage of precarious employment and the social policies in the country.[30] Our study was the  
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first to analyze the association between mortality and type of contract in Italy. According to the Italian Institute of Statistics, the percentage of temporary employment in Italy has increased in the last decades, ranging from a mean of 11.8% of the total dependent employee in 2004 to a mean of 17.0% in 2019.[31] Rising in temporary contracts was mainly explained by the structural reforms that increased flexibility in the labor market over the last decades,[32] as well as the Great Recession in 2008. Regarding gender differences in contracts type, our data based on Rome population agrees with national data, with a higher rate of temporary workers in women than in men. In the population of Rome, the higher percentage of women with temporary contracts in our study can be added to previous results showing that women had a higher rate of unemployment than men.[17]

Our study had some limitations. First, the type of contract was evaluated only at the beginning of the follow-up, i.e., 2001. However, there is substantial agreement between the principal and the sensitivity analyses, although the smaller number of deaths in the latter reduced the significance of the associations. Second, there was a lack of information on employees' health and behavioral risk factors. In particular, it is possible that the health status influenced the probability of having permanent employment, determining a selection bias. Another potential selection bias could be the differential migration from Rome in temporary vs. permanent workers. However, assuming the absence of unmeasured confounders, we used an inverse probability weighting approach to handle missing information on deaths due to lost to follow-up due to migration, obtaining weighted HRs similar to those presented. Finally, since the cohort was followed from 2001 to 2015, the data could be considered dated. However, the 2001 census was the last census that collected information on jobs and type of contracts for the whole population. Therefore, it is the last census that allows analyzing different economic sectors separately.

In conclusion, our results point out that temporary contracts should be considered as an important determinant of health, in particular for workers employed in specific economic sectors. At the health and work policy level, this means that major efforts should be made to reduce precariousness. As a determinant of health, temporary work should be taken into account also in the development of national and local prevention plans, providing specific sector recommendations for both employers and occupational medicine professionals. Prevention strategies, such as information and training should also be implemented.

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3 The well-known heterogeneity in the temporary employees was confirmed by our study  
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5 throughout the different economic sectors. These results highlight the importance of performing  
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7 studies on health outcomes in temporary workers focusing on various economic sectors to  
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9 understand better individual, work-related, and contextual factors linking temporary contracts and  
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11 mortality risk. Future research should confirm these results and evaluate differences among  
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13 countries with different labor market settings.  
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**Contributors**

AN and GC conceived the study, drafted the manuscript and were responsible for the final version of the manuscript. GC handled the permissions and data collection. AN, LDB and GC handled the data management and analyses. NA and MD critically revised the manuscript for important intellectual content. All authors reviewed, read and approved the final manuscript.

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**Competing interests**

None declared.

**Patient consent for publication**

Not required.

**Data availability statement**

Data reported in the manuscript are not publicly available because of stringent legal restrictions regarding privacy policy on personal information in Italy (national legislative decree on privacy policy n. 196/30 June 2003). All data presented in the study are stored by the Department of Epidemiology-Lazio Regional Health Service and only the research team and related Institutions have access to the data. Interested researchers can contact the following persons to request aggregated data: Nera Agabiti (n.agabiti@deplazio.it) and Damiano Lanzi (d.lanzi@deplazio.it).

**Ethics approval**

The Rome Longitudinal Study is approved by the Italian Data Protection Authority (G.U. 16-07-2019 n.165. pag.26. available at:  
[https://www.gazzettaufficiale.it/ricerca/pdf/serie\\_generale/3/0/0?reset=true](https://www.gazzettaufficiale.it/ricerca/pdf/serie_generale/3/0/0?reset=true)).

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## Supplemental Material

### Differences in mortality between temporary and permanent workers: results from the Rome Longitudinal Study.

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**Supplementary Table 1. Characteristics by occupational sector in men, Rome 2001.**

Men	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
<b>Fishing and agriculture</b>	3,927	14.7	7.6	9.8	43.7 (10.9)	271	24.7	7.0
Agriculture, haunting, forestry	3620	14.9	7.5	9.6	44.0 (10.9)	250	26.0	6.8
Fishing, fish farming	307	12.4	8.1	11.4	40.9 (10.6)	21	9.5*	9.5*
<b>Industry</b>	44,568	9.7	18.2	4.8	42 (9.9)	1,897	26.5	6.9
Coal mining, oil extraction	1,829	6.2	29.3	4.6	45.7 (10)	86	24.4	4.7*
Food industry	3,979	10.0	12.0	5.2	41.7 (9.9)	171	26.9	7.6
Textile, leather industry	2,035	14.3	9.0	7.4	41.3 (10.5)	107	33.6	4.7*
Wood, wood products industry. publishing	5,174	9.5	9.2	3.6	42.2 (9.5)	225	28.0	4.4
Refinery, pharmaceutical, chemical industry	5,959	8.8	35.1	4.9	42.5 (9.8)	211	25.1	6.6
Non-metal mineral industry	1,348	13.8	7.8	7.6	41.5 (10.2)	71	38.0	5.6*
Steel industry	17,755	10.6	17.8	4.8	41.1 (9.8)	728	25.7	8.8
Furniture industry	1,651	13.3	6.8	7.6	41.1 (10.8)	89	18.0	5.6*
Production, distribution of electricity, water and gas	4,838	4.9	19.6	2.6	44 (9)	209	25.4	5.3
<b>Building Constructions</b>	21,058	14.2	10.2	7.1	41.5 (10.7)	1,047	27.7	8.2
<b>Sales and Transport</b>	79,626	11.0	9.4	5.6	41.1 (10.1)	3,265	26.3	6.9
Sale, maintenance, repair of motor vehicles, sale of fuel	8,449	11.6	6.1	4.8	40.3 (10.3)	345	22.3	5.8
Wholesale trade, intermediaries of trade	7,795	11.4	8.4	5.2	39.9 (10)	261	25.3	6.1
Retail trade	13,546	13.0	5.9	5.1	39.4 (10.4)	547	23.8	7.3
Hotels, camping, bars, restaurants	13,147	13.8	4.8	13.5	39.5 (10.2)	561	27.5	9.1
Transport	36,689	9.1	13.4	3.2	42.7 (9.8)	1,551	27.9	6.3
<b>Credit, insurances and other services</b>	51,771	9.2	32.4	3.1	41 (9.9)	1,806	26.4	4.9
Credit, insurance, monetary, financial intermediation	23,179	4.6	29.5	2.6	45 (9.3)	1,059	25.0	4.6
IT, research, development	18,870	11.4	35.0	3.0	36.9 (8.6)	383	29.8	5.7
Professional consulting, real estate, rental	9,722	15.6	34.1	4.4	39.1 (10.1)	364	26.6	4.7
<b>Social services</b>	117,812	7.8	29.7	4.2	44.2 (9.9)	5,910	26.6	5.6

Supplementary Table 1. *Continued*

	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
Local, national, public administration	66,677	4.5	21.0	2.7	44 (9.8)	3,245	27.1	5.4
Public, private education	15,276	11.6	62.9	4.3	47.3 (9.6)	897	25.6	4.8
Health, social assistance	19,331	8.5	45.7	3.3	44.7 (9.4)	1,003	27.6	6.2
Political, trade union organizations	2,404	11.9	35.9	3.0	43.9 (10)	111	29.7	2.7*
Recreational, cultural, sports activities	5,143	27.1	22.8	5.5	41 (10)	217	22.6	9.7
Other service activities	4,939	12.2	5.5	4.9	40.3 (9.8)	211	21.8	8.5
Domestic services	4,042	11.5	4.9	32.1	42.9 (10.1)	226	26.1	3.5*
<b>International organizations</b>	1,892	12.2	32.2	20.6	44.7 (9.9)	94	27.7	7.4*

\* Less than 10 deaths

CV cardiovascular

AC accidental

Supplementary Table 2. Characteristics by occupational sector in women, Rome 2001.								
Women	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
Fishing and agriculture	3,032	20.4	8.4	12.0	43.7 (10.3)	114	23.7	0.9*
Agriculture, haunting, forestry	2,917	20.3	7.9	12.2	43.9 (10.2)	113	24.0	0.9*
Fishing, fish farming	115	25.2	20.9	6.1	40.1 (10.9)	1	0.0	0.0
Industry	19,721	13.9	18.9	7.3	39.8 (9.4)	423	16.5	5.7
Coal mining, oil extraction	964	9.2	20.4	4.9	43 (9)	19	5.3*	0.0
Food industry	1,797	15.2	13.5	9.1	39.4 (9.9)	36	25.0*	11.1*
Textile, leather industry	3,553	18.7	6.3	9.8	40.1 (10.1)	96	16.7	4.2*
Wood, wood products industry, publishing	2,313	13.1	17.8	4.5	40.2 (9)	47	12.8*	4.3*
Refinery, pharmaceutical, chemical industry	3,360	13.0	37.6	7.2	38.6 (8.7)	61	21.3	9.8*
Non-metal mineral industry	393	16.5	13.0	11.2	39.3 (9.7)	13	0.0	15.4*
Steel industry	5,137	14.0	17.9	7.3	39.5 (9.3)	105	15.2	3.8*
Furniture industry	583	17.5	10.5	9.3	38.2 (9.6)	12	16.7*	8.3*
Production, distribution of electricity, water and gas	1,621	5.6	22.2	3.8	41.6 (8.6)	34	20.6*	2.9*
Building Constructions	3,612	14.3	15.9	4.1	38 (9)	74	16.2	4.1*
Sales and Transport	51,334	14.6	11.9	5.7	38.3 (9.5)	980	13.5	4.7
Sale, maintenance, repair of motor vehicles, sale of fuel	3,241	14.9	10.9	4.4	38.2 (9.5)	68	7.4*	5.9*
Wholesale trade, intermediaries of trade	5,755	13.3	9.6	5.3	37.7 (9.1)	105	16.2	5.7*
Retail trade	16,323	15.9	6.8	5.3	37.8 (9.9)	317	14.2	4.4
Hotels, camping, bars, restaurants	10,361	16.8	5.5	8.6	38.4 (9.8)	215	15.3	5.1
transport	15,654	12.0	22.6	4.7	39 (9.1)	275	11.6	4.0
Credit, insurances and other services	42,745	14.0	25.6	3.9	37.6 (8.8)	727	12.2	4.5
Credit, insurance, monetary, financial intermediation	16,469	8.3	23.2	3.6	40.4 (8.8)	359	13.1	3.1
IT, research, development	10,517	16.5	37.6	3.5	35.2 (7.5)	134	8.2	6.0*
Professional consulting, real estate, rental	15,759	18.2	20.1	4.4	36.4 (8.7)	234	13.2	6.0
Social services	154,755	12.5	33.0	6.3	43.3 (9.3)	4,493	14.8	3.4

**Supplementary Table 1. Continued**

	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
Local, national, public administration	54,091	5.9	25.3	3.1	44.3 (8.6)	1.676	15.0	4.3
Public, private education	45,229	16.7	50.8	4.6	45.2 (9.2)	1.416	13.4	2.5
Health, social assistance	31,890	11.7	34.2	4.8	41.3 (9.3)	832	14.9	3.7
Political, trade union organizations	3,618	12.9	25.4	3.9	40.9 (9)	87	17.2	1.1*
Recreational, cultural, sports activities	5,433	31.2	31.9	6.0	38.8 (9.4)	117	9.4	4.3*
Other service activities	5,473	17.3	6.4	5.4	37.9 (9.9)	127	18.1	2.4*
Domestic services	9,021	18.8	5.5	40.4	42.4 (10.1)	238	21.0	3.4*
<b>International organizations</b>	1,981	17.6	41.5	39.0	43.6 (9.4)	35	5.7*	0.0

\* Less than 10 deaths

CV cardiovascular

AC accidental

**Table S3. Association between temporary employment and mortality in men and women. Rome 2001-2015**

	Men									Women								
	Overall mortality			CV mortality			AC mortality			Overall mortality			CV mortality			AC mortality		
	HR	95% CI		HR	95% CI		HR	95% CI		HR	95% CI		HR	95% CI		HR	95% CI	
<b>HR adjusted for age and level of education</b>																		
Overall	1.13	1.06	1.20	1.25	1.11	1.41	1.31	1.06	1.61	1.01	0.93	1.10	0.97	0.77	1.22	1.35	0.95	1.93
Sector of employment*																		
Fishing and agriculture	0.85	0.57	1.25	1.33	0.68	2.59	1.02	0.28	3.69	0.67	0.39	1.18	0.47	0.14	1.57	-	-	-
Industry	1.21	1.02	1.42	1.11	0.80	1.54	1.61	0.98	2.64	0.98	0.71	1.36	1.52	0.76	3.05	2.19	0.80	6.02
Building Constructions	1.23	1.03	1.46	1.22	0.87	1.70	1.21	0.69	2.14	0.91	0.37	2.22	4.79	0.83	27.5	-	-	-
Sales and Transport	1.08	0.95	1.23	1.27	1.00	1.61	1.10	0.74	1.64	1.23	1.01	1.50	1.29	0.77	2.13	1.53	0.70	3.37
Credit, insurances and other services	1.09	0.88	1.35	1.20	0.79	1.81	0.98	0.43	2.24	0.88	0.67	1.17	0.80	0.34	1.88	0.96	0.31	2.90
Social services	1.13	1.01	1.26	1.29	1.05	1.59	1.38	0.95	2.00	0.99	0.89	1.11	0.82	0.60	1.13	1.27	0.78	2.06
<b>HR adjusted for age, level of education, and place of birth</b>																		
Overall	1.13	1.06	1.21	1.25	1.11	1.42	1.31	1.07	1.61	1.02	0.93	1.11	0.96	0.77	1.21	1.36	0.96	1.94
Sector of employment*																		
Fishing and agriculture	0.94	0.62	1.40	1.54	0.77	3.09	1.08	0.27	4.34	0.78	0.44	1.37	0.54	0.16	1.83	-	-	-
Industry	1.21	1.03	1.43	1.09	0.78	1.52	1.65	1.00	2.72	0.98	0.71	1.37	1.51	0.73	3.11	1.95	0.69	5.57
Building Constructions	1.22	1.02	1.46	1.20	0.85	1.69	1.26	0.71	2.24	1.12	0.42	3.01	3.95	0.58	27.1	-	-	-
Sales and Transport	1.08	0.95	1.23	1.27	1.00	1.61	1.10	0.74	1.64	1.24	1.02	1.51	1.28	0.77	2.14	1.54	0.70	3.41
Credit, insurances and other services	1.11	0.89	1.38	1.23	0.81	1.86	1.00	0.44	2.28	0.91	0.68	1.20	0.89	0.38	2.10	0.96	0.31	2.92
Social services	1.13	1.01	1.27	1.30	1.06	1.60	1.39	0.96	2.02	0.99	0.89	1.11	0.82	0.59	1.12	1.27	0.78	2.07

CV cardiovascular

AC accidental

\*Sum of macro-sectors differs from the overall population because the international organizations sector, contributing with 94 and 35 deaths for men and women respectively, was not showed.



**Table S4. Association between temporary employment and mortality in men and women. Rome, 2001-2006**

	N	Overall mortality			N	CV mortality			N	AC mortality		
	deaths	HR	95% CI		deaths	HR	95% CI		deaths	HR	95% CI	
<b>Men</b>												
Overall	3,657	1.13	1.00	1.28	1,003	1.31	1.04	1.65	345	1.11	0.79	1.56
Sector of employment*												
Fishing and agriculture	66	1.40	0.72	2.69	14	3.25	1.00	10.6	6	1.12	0.13	10.03
Industry	477	1.18	0.85	1.63	161	1.40	0.82	2.37	52	1.12	0.48	2.61
Building Constructions	297	1.14	0.81	1.61	90	1.31	0.73	2.38	36	1.13	0.46	2.75
Sales and Transport	836	1.16	0.90	1.48	230	1.25	0.79	2.00	91	0.90	0.47	1.75
Credit, insurances and other services	439	1.42	0.96	2.09	110	2.07	1.03	4.14	37	1.41	0.50	4.00
Social services	1,517	0.92	0.73	1.17	391	0.85	0.52	1.39	122	1.01	0.52	1.97
<b>Women</b>												
Overall	1,638	1.01	0.84	1.20	222	1.16	0.74	1.83	94	1.61	0.93	2.77
Sector of employment*												
Fishing and agriculture	33	0.95	0.39	2.35	5	-	-	-	1	-	-	-
Industry	100	0.86	0.43	1.71	14	1.70	0.37	7.68	12	0.70	0.09	5.52
Building Constructions	19	1.31	0.29	5.94	2	16.8	1.03	274.5	-	-	-	-
Sales and Transport	245	1.38	0.95	2.00	36	1.05	0.37	3.02	14	2.31	0.63	8.43
Credit, insurances and other services	175	0.82	0.46	1.46	20	1.84	0.51	6.63	16	0.48	0.06	3.83
Social services	1,060	0.93	0.73	1.18	145	1.02	0.55	1.91	51	1.93	0.95	3.95

HR adjusted for age

CV cardiovascular

AC accidental

\*Sum of macro-sectors differs from the overall population because the international organizations sector, contributing with 94 and 35 deaths for men and women respectively, was not showed.

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**Table S5. Association between temporary employment and mortality by sex and type of work, Rome 2001-2015**

	Overall mortality					CV mortality				AC mortality			
	N	Deaths	HR	95% CI		Deaths	HR	95% CI		Deaths	HR	95% CI	
Men													
Overall	320,654	14,290	1.16	1.09	1.24	3,793	1.29	1.14	1.45	884	1.27	1.04	1.57
High-skill non manual	86,759	3,826	1.05	0.92	1.20	1,019	1.34	1.06	1.70	197	1.19	0.73	1.94
Low-skill non manual	94,764	3,989	1.14	0.99	1.31	1,037	1.15	0.88	1.51	244	1.37	0.89	2.11
Sales	37,183	1,452	1.22	1.02	1.46	367	1.33	0.94	1.89	115	1.75	1.07	2.87
Manual	86,555	4,646	1.16	1.05	1.28	1,273	1.24	1.03	1.50	296	1.22	0.88	1.69
Women													
Overall	277,180	6,846	1.03	0.95	1.12	997	1.02	0.81	1.28	262	1.34	0.94	1.91
High-skill non manual	61,000	1,502	0.97	0.80	1.19	188	1.22	0.72	2.10	45	1.72	0.75	3.97
Low-skill non manual	142,773	3,358	1.07	0.94	1.22	455	0.82	0.55	1.24	127	1.04	0.57	1.87
Sales	35,679	757	1.03	0.82	1.30	124	0.97	0.54	1.72	41	1.75	0.82	3.75
Manual	37,668	1,228	0.95	0.80	1.13	230	1.04	0.70	1.54	49	1.28	0.62	2.65

HR adjusted for age  
CV cardiovascular  
AC accidental

## STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls (c) <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed (c) <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5,6
Bias	9	Describe any efforts to address potential sources of bias	6, 7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6, 7
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	5
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed (e) <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed (f) <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	5, 7, 16
		(g) Describe any sensitivity analyses	6,7

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<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7, 8
		(b) Indicate number of participants with missing data for each variable of interest	-
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	7
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	7
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-13
		(b) Report category boundaries when continuous variables were categorized	8
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	15, 16
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).